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RESOURCE DATA AND SPECIES AT RISK SECTION

The Southern Headwaters At Risk Project: A Multi-Species Conservation Strategy for the Headwaters of the Oldman River

Volume 3

Landscape Management – Selection and Recommendations

Alberta Species at Risk Report No. 105

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

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Landscape Management – Selection and Recommendations

By

François Blouin

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EXECUTIVE SUMMARY

The Southern Headwaters at Risk Project provides a holistic approach to managing multiple species at risk in the headwaters area of the Oldman River and ensuring the long-term sustainability of their populations. In an initial step, a group of focal species that are most representative of multiple species with similar habitat requirements and threats were selected (Blouin *et al.* 2004). Habitat suitability index (HSI) models were developed for those focal species, the HSI models were combined to determine the ecological "hot spots" on the landscape, and then analyzed to determine priority areas for management activities or habitat stewardship efforts aimed at conserving multiple species at risk.

In order to provide landscape management recommendations it was first necessary to determine appropriate land management units applicable to the focal species within the project area. Once the land management units were selected, the SHARP area was prioritized based on criteria that applied to those units. Because of differences in the base maps used to develop the HSI models and differential land uses among the focal species, the project area was divided into two landscapes – forest landscape and grassland landscape.

This report outlines the landscape management unit selection process, including the method used for determining multi-species conservation values (MCVs) for the focal species, and provides management recommendations to apply at the landscape level and at the management unit level. These recommendations were developed to limit or reverse the impact(s) of threatening processes on the focal species and to address the complexity of habitat requirements of multiple species at multiple scales.

1.0 INTRODUCTION

The Southern Headwaters at Risk Project (SHARP) strives to maximize the number of species at risk of extirpation that can be protected in the project area, while minimizing the resources (human and financial) that are required to achieve this goal (Blouin *et al.* 2004). The initial step of this approach involved the selection of a group of focal species whose habitat requirements were thought to encompass that of a large number of species at risk in the area, and to develop habitat suitability index (HSI) models (USFWS 1981) for these focal species (Blouin *et al.* 2004). HSI models were developed both mathematically and spatially through the use of a geographic information system (GIS). These HSI models can be combined to determine the ecological "hot spots" on the landscape, and analyzed to determine priority areas for management activities or habitat stewardship efforts aimed at conserving multiple species at risk.

The goal of the current report was to develop a suitable set of management units for the conservation of multiple species at risk at the landscape level, and to prioritize the SHARP area based on criteria that apply to those units. More specifically, the objectives were: 1) to assess the minimum area requirements of focal species and the scale at which management units need to be developed, 2) to combine HSI models into a multi-species conservation map using a weighted mathematical relationship (modified from Akçakaya 2000 and Jones and Downey 2004), 3) to prioritize the SHARP area based on management unit multi-species conservation values, and 4) to produce a map of priority areas for the conservation of multi-species at risk in the SHARP area.

2.0 LANDSCAPE MANAGEMENT UNIT SELECTION

Of the 15 HSI models developed previously (Blouin *et al.* 2004), 14 were used for landscape prioritization. The grizzly bear model was undergoing refinement at the time of this exercise and was thus excluded from the analyses. In addition, the trumpeter swan model that had been developed mathematically and spatially but not included in Blouin *et al.* (2004) was added to the prioritization exercise. As a result, a total of 15 habitat suitability index models were used to prioritize the SHARP area (Table 1).

Differential use of the SHARP area by the focal species and differences in base maps used to produce the HSI models between predominantly forest species and predominantly grassland species (Blouin *et al.* 2004) prescribed a division of the SHARP area into two landscapes. The common area to all forest species' HSI models combined is presented in Figure 1(a), and thus represented the "artificial" extent of the forest landscape.

Similarly, the common area to all grassland species' HSI models combined is presented in Figure 1(b), and represented the "artificial" extent of the grassland landscape. The northern leopard frog and the trumpeter swan models overlapped the two landscapes and were included in the analyses of both landscapes. Spatial analyses were conducted using ArcView® 3.2 GIS on 25 m raster (pixel) data.

Table 1. Focal species whose HSI model was used in prioritizing the SHARP landscape and the life requisite(s) assessed by the model.

Common Name	Scientific Name	Life Requisite(s) Assessed by HSI Model
Trumpeter swan	*Cygnus buccinator*	Breeding habitat
Harlequin duck	*Histrionicus histrionicus*	Breeding habitat
Ferruginous hawk	*Buteo regalis*	Breeding habitat
Prairie falcon	*Falco mexicanus*	Nesting and foraging habitats
Sharp-tailed grouse	*Tympanuchus phasianellus*	Year-round habitat
Long-billed curlew	*Numenius americanus*	Breeding habitat
Pileated woodpecker	*Dryocopus pileatus*	Year-round habitat
Clark's nutcracker	*Nucifraga columbiana*	Spring to fall habitat
Sprague's pipit	*Anthus spragueii*	Breeding habitat
Loggerhead shrike	*Lanius ludovicianus excubitorides*	Breeding habitat
Vagrant shrew	*Sorex vagrans*	Year-round habitat
Wolverine	*Gulo gulo*	Breeding habitat
Northern leopard frog	*Rana pipiens*	Year-round habitat
Western toad	*Bufo boreas*	Year-round habitat
Long-toed salamander	*Ambystoma macrodactylum*	Year-round habitat

Figure 1. Extent of the forest (a) and grassland (b) landscapes in the SHARP area.

3.1 Landscape Management Unit Determination

In his focal species approach, Lambeck (1997) claimed that the needs of the focal species defined the minimum threshold that must be exceeded if the needs of the suite of species they represent are to be met. In an attempt to determine a suitable landscape management unit for a group of focal species, one must therefore consider the needs for space of those focal species that are area-limited. Ideally, a suitable management unit should be one that is large enough to encompass the needs for the species with the greatest area requirements.

3.1.1 Forest Landscape

In the SHARP forest landscape, the area-limited focal species with the greatest area requirements is the wolverine. Although known to occupy very large yearly home ranges (up to 963 km^2; Hornocker and Hash 1981, also see Banci 1994), breeding wolverines close to the SHARP area were found to occupy a home range of 100 km^2 (Hornocker and Hash 1981). J.P. Copeland (pers. comm.) estimated that female wolverines in Glacier National Park, Montana, traveled on average a minimum of 4 km per day for foraging until weaning. A 4 km radius was thus used to determine the minimum circular area requirement of 50.27 km^2 for a breeding female wolverine. This represented the smallest unit of management for the forest landscape.

The wolverine habitat suitability map was used to generate habitat patches (Jokinen 2004). Habitat patches were generated by the Patch Analyst 3.0 (Rempel and Carr 2003) ArcView® extension using the orthogonal method for clumping contiguous pixels (Elkie *et al.* 1999). As a wide-ranging species, it was assumed that the wolverine could use areas of lower habitat quality to access better quality areas (Hornocker and Hash 1981, Copeland 1996) but tended to avoid areas associated with human features (Jokinen 2004). As a result, areas of the wolverine model (Jokinen 2004) with HSI values > 0 were considered contiguous for the purpose of patch (landscape management unit) creation.

3.1.2 Grassland Landscape

The approach used for the grassland landscape varied slightly from that used in the forest landscape. In the forest landscape, the primary base map, the Alberta Vegetation Inventory was produced using vegetation (and non-vegetation) cover with a positional accuracy of ± 20 metres (AVI; Alberta Environmental Protection 1991). In the grassland landscape, the primary base map was the Native Prairie Vegetation Inventory (NPVI; Resource Data Branch 1995) with a quarter section as the mapping unit. As a result, the resolution of the AVI is much greater than that of the NPVI, and AVI polygons follow a somewhat "natural" vegetation line rather than a political line. A landscape management unit in the grassland landscape should therefore be represented as a multiple of the quarter section.

Of all grassland focal species, only the ferruginous hawk and the prairie falcon could require a minimum area larger than a quarter section (64 ha). According to Schmutz (1977), ferruginous hawk nesting sites in southeastern Alberta were rarely closer than 800 m from the next nearest ferruginous hawk nest. This implies that there could potentially be up to one ferruginous hawk nest per quarter section (800 m x 800 m), and a quarter section would be a suitable management unit for this species. On the other hand, the prairie falcon is highly mobile and can adequately care for its young if foraging less than 15 km from its nest (Marzluff *et al.* 1997). There does not appear to be a minimum area requirement for this species and foraging ranges of adjacent nesting pairs in southern Alberta overlapped up to 100% (Hunt 1993). However, it is highly dependent on ground squirrels (Hunt 1993), whose minimum area requirements are captured within a quarter section unit. The quarter section was thus considered a suitable landscape management unit (LMU) for the grassland landscape.

3.2 Multi-Species Conservation Value

A multi-species conservation value (MCV) was derived as a first step in the landscape prioritization process. The MCV provides a weighted average of all focal species habitat suitability maps (Akçakaya 2000). The weight was based on the level of endangerment of the focal species. This considers that areas used by species at greater risk of extinction have higher conservation values than areas used by species at lower risk (Akçakaya 2000).

The MCV was calculated for each 25 m pixel using the following formula (modified from Jones and Downey 2004):

$$MCVj = \frac{\sum_{i=1}^{n} (HSIij * SSi)}{n}$$

where:

MCVj = multi-species conservation value at location (pixel) j
n = number of focal species (terrestrial or aquatic) in the landscape
HSIij = the habitat suitability index value for focal species i at location j
SSi = the species status weighting value for focal species i

Aquatic habitat MCVs were calculated separately from the terrestrial habitat MCVs. The potential trumpeter swan habitat and the aquatic portion of the harlequin duck, northern leopard frog, western toad, and long-toed salamander potential habitat made up the aquatic portion of the landscape in the forested area. The trumpeter swan habitat, and the aquatic portion of the northern leopard frog and the long-toed salamander made up the aquatic portion of the landscape in the grassland area. The terrestrial portion of those species' potential habitat was included in the terrestrial MCV equation. The number of species (n) in MCV calculations represented the number of species in each habitat type of each landscape.

In the grassland landscape, all high potential "cliff" areas (slope variable V1 = 1 in the prairie falcon HSI model; Downey 2004a) were considered strictly prairie falcon habitat. Therefore, MCVs for these areas took the full weighted maximum V1 value for the prairie falcon.

3.3 Species Status Weight

A species status weight (SS) was developed based on the focal species' level of endangerment (Table 2). Species in Alberta can be legally designated under both Alberta's *Wildlife Act* and the federal *Species at Risk Act* (SARA). In addition, vertebrate animal species have been ranked provincially under the General Status of Alberta Species 2000 (Alberta Sustainable Resource Development 2001) or federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a first step in the assessment process toward a potential legal designation at their respective political level.

Table 2. Focal species ranking and species status weight based on level of endangerment.

Species	Alberta General Status[1] / Score	Alberta *Wildlife*[2] *Act* / Score	SARA or COSEWIC / Score	Species Status Weight (SS)
Trumpeter swan	At Risk / 5	Threatened / 4	Not At Risk / 1	4
Harlequin duck	Sensitive / 3	Migratory Game Bird / (Special Concern) / 3	Not assessed / 2	3
Ferruginous hawk	At Risk / 5	Threatened / 4	Special Concern / 3	4
Prairie falcon	Sensitive / 3	Bird of Prey (Special Concern) / 3	Not at Risk / 1	3
Sharp-tailed grouse	Sensitive / 3	Upland Game Bird (Not assessed) / 2	Not assessed / 2	3
Long-billed curlew	May be at Risk / 4	Non-Game Animal (Special Concern) / 3	Special Concern / 3	3
Pileated woodpecker	Sensitive / 3	Non-Game Animal (Not assessed) / 2	Not assessed / 2	3
Clark's nutcracker	Secure / 1	Non-Game Animal (Not assessed) / 2	Not assessed / 2	1
Sprague's pipit	Sensitive / 3	Non-Game Animal (Special Concern) / 3	Threatened / 5	3
Loggerhead shrike	Sensitive / 3	Non-Game Animal (Special Concern) / 3	Threatened / 5	3
Vagrant shrew	May be At Risk / 4	Non-Game Animal (Not assessed) / 2	Not assessed / 2	4
Wolverine	May Be At Risk / 4	Fur-Bearing Animal (Data Deficient) / 2	Special Concern / 3	3.5
Northern leopard frog	At Risk / 5	Threatened / 4	Special Concern / 3	4
Long-toed salamander	Sensitive / 3	Non-Game Animal (Special Concern) / 3	Not assessed / 2	3
Western toad	Sensitive / 3	Non-licence Animal / (Not assessed) / 2	Special Concern / 3	3

[1] Alberta Sustainable Resource Development (2001)
[2] Alberta Endangered Species Conservation Committee recommendations in brackets.

The *Wildlife Act* score was given highest priority in determining the final weighting value because considerations for the designation of species apply strictly to the province and species have received a detailed assessment following their ranking under the General Status of Alberta Species 2000 (Alberta Sustainable Resource Development 2001). When not designated as "Endangered" or "Threatened" under the *Wildlife Act*, the recommendations by the Alberta Endangered Species Conservation Committee (ESCC) were used to establish a score. When a species was "not assessed " or considered "data deficient" by the ESCC, the average score between the General Status of Alberta Species 2000 (Alberta Sustainable Resource Development 2001) and the COSEWIC was used. If a species was "not assessed" or "data deficient" under two of the three status designates, the score from the remaining designate was taken. A higher score was given to species that were "not assessed" or "data deficient" than those that were considered "not at risk" or "secure" to account for the fact that an assessment of that species could put it at a higher risk category.

3.4 Landscape Prioritization for Multi-Species Conservation Initiatives

3.4.1 Forest Landscape

Prioritization of the forest landscape was carried out in two steps. The first steps consisted of prioritizing the patches (LMUs) of habitat based on their relative conservation value. Patch conservation values were calculated by summing all the MCVs of the pixels that fell within them (Akçakaya 2000), and by dividing the total by the patch area (in hectares). An equal area classification method (ESRI 1996) was applied to create five patch priority categories. These categories were labeled as "very low priority" to "very high priority". The second step prioritized the area of each patch based on pixel MCVs. Pixel MCVs were classified into five priority categories of roughly equal intervals. These categories were labeled as "very low priority area" to "very high priority area" within LMUs.

3.4.2 Grassland Landscape

The conservation value of each quarter section (landscape management unit) was calculated by summing all the MCVs of the pixels that fell within the quarter section (Akçakaya 2000). Since the boundary of the SHARP area does not follow the jagged pattern of quarter section boundaries, and since there are fractional ranges that border the fifth meridian running north - south just west of Pincher Creek, the total conservation value per quarter section was divided by the quarter section area (in hectares). The result gives a relative conservation value that can be compared between management units.

3.5 Limitations

The GIS HSI models used to carry out the SHARP landscape prioritization process are working models still under revision and have not been validated with empirical data. As such, the current prioritization of the SHARP landscape builds on the assumption that the models are accurate at representing the "true" habitat suitability of the land for each species. This assumption may have serious implications if management activities are initiated and financial and human resources are being deployed. The author recommends that validation of each HSI model with empirical data

from field studies precedes any conservation and management activities and resource expenditures in the area (Storch 2002). Changes to the HSI models may be required and may have implications on the final prioritization of the SHARP landscape. In addition, the HSI models are static in time and space and as such, do not account for the dynamic nature of the natural or anthropogenic patterns and processes taking place over the landscapes. This may be more important in the forest landscape where some anthropogenic disturbances, such as logging and mining, and natural disturbances, such as wild fires and windthrows may have greater and longer-lasting impacts on habitats over time than the processes taking place in the grassland.

4.0 RESULTS

4.1 Forest Landscape Prioritization

4.1.1 Landscape Prioritization

A total of 607 habitat patches (LMUs) were created. Habitat patches that did not meet the wolverine minimum area requirement of 50.27 km^2 were not considered in the prioritization process regardless of their average patch MCV. Exception to this was the "peninsula" of land in the west central part of the SHARP area (patch #1 in Appendix 1) that projects into British Columbia. This patch was only 17.9 km^2, but was assumed to meet the minimum size requirement when the adjacent portion of habitat in British Columbia was considered. Fourteen patches met the minimum area requirement. Relative MCV per hectare for these patches varied between "2.60" and "8.08" (Appendix 1).

4.1.2 Patch Prioritization

Pixel MCV values per patch varied between "0" and "2.02". This range was divided into four priority categories for habitat stewardship activities (Appendix 2). The "high" priority category represented between 0.5 % and 17.4 % of individual patch areas, and 5 % of the total area of all patches in the forest landscape.

4.2 Grassland Landscape Prioritization

MCV values for the grassland landscape varied between "0" and "3.2" per pixel. Total MCVs per hectare on quarter section (landscape management) units varied between "0" and "42.73". This range was divided into five priority categories for stewardship activities (Appendix 3). The "very high" priority category represented about 4.7 % of the extent of the grassland landscape.

5.0 RECOMMENDATIONS FOR THE LANDSCAPE MANAGEMENT UNITS OF THE SOUTHERN HEADWATERS AREA

In the previous volume, fifteen habitat suitability index (HSI) models were combined and analyzed to identify the highest priority areas, or "hot spots" for multi-species at risk management and conservation in the southern headwaters area. In this effort, the forest and the grassland landscapes were analyzed separately and yielded spatially different landscape management units representative of the most area-limited focal species that occur within each

landscape. In the forest landscape, the wolverine was considered the most area-limited and habitat patches greater or equal to 50.27 km^2 represented the management units. In the grassland landscape, the political boundary of a quarter section from the Alberta Township Survey (ATS) system was considered a suitable management unit for the most area-limited species, the ferruginous hawk. Prioritization of the forest and grassland management units was based on a multi-species conservation index. This index integrates information about the habitat and the level of endangerment of the focal species.

Once priority management units for the focal species have been identified, land managers (either public or private) are concerned about how and when to manage these units of land in order to benefit multiple species at risk. The objective of the present volume was to provide management recommendations for the landscape management units (LMUs) that resulted from the analyses of multiple HSI models.

In the SHARP project, focal species were selected based on the knowledge that they perform critical ecological functions and/or are viewed as best representatives of species with specific ecological requirements. The premise behind this effort was that, by protecting essential patterns and processes of the focal species, their habitat will be maintained, and that of other species dependant upon similar attributes will also be protected.

Threatening ecosystem patterns and processes were defined for the SHARP focal species (see Volume 4). In order to ensure an efficient use of limited resources in focal species management, the SHARP forest and grassland landscapes were prioritized based on their value for the conservation of multi-species at risk. In those areas, management activities may need to be undertaken to restore the ecological functions required by the focal species, or conservation measures may be put in place to prevent their loss. Management recommendations are not designed to create new habitats for the focal species, but rather to improve existing habitats or prevent them from being degraded or lost. The following recommendations attempt to ensure that the focal species' habitat requirements are met in order to ensure the long-term survival of species at risk populations in the area, and preventing others from becoming at risk of extirpation.

6.0 MANAGEMENT RECOMMENDATIONS

6.1 Forest Landscape

A total of 14 management units were identified in the forest landscape. Of those, four were classified as "very high priority", one of "high priority", two of "medium priority", two of "low priority", and four of "very low priority" for multi-species management and conservation purposes. Some of these LMUs cover very large areas as only a minimum size was set for their determination. Forest LMUs were thus further subdivided to better focus management activities. Management can thus be applied at multiple scales, with subunits being nested within LMUs that are further nested within the full extent of the forest landscape.

6.1.1 Landscape-Level Management: The Need for Space

The wide-ranging wolverine can only persist in areas managed at the landscape, regional, or even higher level (Hornocker and Hash 1981, Banci 1994, Krebs *et al.* 2004). For example, if LMUs of the SHARP forest landscape were managed individually for the wolverine without taking into consideration the surrounding areas, or if only high priority LMUs were considered, then only denning and kit rearing habitats would be protected. The other life requisites of the wolverine (e.g., dispersal, immigration, mating) essential to sustain populations and metapopulations would not be fulfilled within those units, especially in harvested populations. Based on survivorship data from twelve North American studies, Krebs *et al.* (2004) concluded that functioning linkages between and among southern British Columbia, Alberta, Montana, Idaho, and Washington were essential for the persistence of wolverines in the southern extent of their range. Therefore, not only LMUs containing wolverines need to be linked among one another, but the SHARP forest landscape also needs to be connected with habitat patches located outside the southern headwaters area.

For that reason, I recommend that the entire SHARP forest landscape be surveyed for wolverine (see methods in Mowat 2001). During the denning period, surveys should focus on those highly suitable areas identified in the wolverine HSI model (see Jokinen 2004). All habitat patches (or LMUs) that contain wolverines or wolverine signs should be managed for the wolverine to ensure that the processes and habitat characteristics required for the persistence of that species are maintained. Linkages between habitat patches and between habitat patches and key winter ungulate areas should be identified and maintained. Linkages to other areas of known wolverine habitat, key winter ungulate areas, or protected areas outside the SHARP forested landscape (e.g. Waterton Lakes and Glacier National Parks) should be identified and maintained in order to ensure dispersal and immigration movements between those areas and movement of males within their larger home ranges that overlap those of females (Petersen 1997). The Beneficial Management Practices (BMPs) developed in Volume 4 should be implemented in the identified critical denning, post-weaning, and movement corridor areas.

6.2 Landscape Management Unit-Level Management

6.2.1 Limiting Resources Management

Limber and Whitebark Pines: In the southern headwaters area, the Clark's nutcracker is highly dependant on the limber and whitebark pines for its survival, and in turn, these large-seeded pines are highly dependant on the Clark's nutcracker for post-disturbance regeneration (Tomback 1998). Limber and whitebark pines are no longer harvested in Alberta (Dhir *et al.* 2003, B. Wilson, pers. comm.) and thus are protected from direct anthropogenic threats. However, these and other five-needle pine species are being threatened by the changes in natural processes resulting from fire suppression, white pine blister rust (*Cronartium ribicola*) and mountain pine beetle (*Dendroctonus ponderosae*) epidemics, and the rapid change in global climate (Peterson 1999, Tomback 2003, Wilson 2003; see details in Volume 4). Managing for healthy populations of these threatened pines is therefore essential for maintaining Clark's nutcracker populations and the long-term sustainability of limber and whitebark pine populations in the southern headwaters area.

Limber and whitebark pine stands should be surveyed in priority LMUs. The current Alberta Vegetation Inventory (AVI) identifies some of these stands. However, according to N. Dhir (pers. comm.), the inventory is not accurate at identifying those two pine species. Mapping of whitebark pine locations based largely on anecdotal information was carried out for the C5 Forest Management Unit in 2003. These locations were incorporated into the Clark's Nutcracker's HSI model (see Blouin 2004). Ground-truthing of the 2003 data and some of the AVI data was done in 2004. Positive and negative data that resulted from this exercise should be combined with the HSI model for more accurate mapping. In addition, stands categorized as "undifferentiated pine" (category "P"; Nesby 1996) in the AVI database as well as whitebark and limber pine locations that have not been ground-truthed in 2004 should be visited in the targeted LMUs. A health assessment of whitebark and limber pine stands should also be carried out to determine their viability. Rust-resistant trees should be identified and used as a seed source for a breeding program. Rust-resistant seed or seedling should be planted at sites where pine trees have been damaged by diseases and where seed production has been reduced. Details on site-level management activities can be found in Volume 4.

Monitoring of the limber and whitebark pine stands and the Clark's nutcracker populations will also be essential in order to assess the efficiency of the management measures. The province currently maintains a small seed collection of the two species and has methods, systems and standards in place for seed zones, regeneration success monitoring and juvenile growth performance. A small in situ and ex situ conservation program for both species is also in place and being expanded (Dhir *et al.* 2003). Managers in the southern headwaters area should take advantage of these methods and standards and seek to integrate the limber and whitebark pine management into the provincial conservation program.

<u>Water Bodies (trumpeter swan)</u>: The trumpeter swan is also a resource-limited species that primarily depends on suitable water bodies for breeding (see Mitchell in Appendix B of Pacific Flyway Study Committee 2004). The number of potential nesting water bodies is highly limited in the forest landscape and most occur in the grassland landscape (R. Quinlan, unpublished HSI model). For that reason, I suggest that all suitable and highly suitable water bodies identified in the HSI model be surveyed during the breeding season in priority LMUs. Spring and fall migration surveys should also be conducted to identify important staging water bodies. Where trumpeter swans occur, an access management plan should be developed and implemented according to their seasonal use by the swans, in order to minimize the impact of human disturbance on and in proximity of water bodies. The BMPs presented in Volume 4 and the land use guidelines developed and modified by the Alberta Fish and Wildlife Division (2001) should be implemented in the area. Known breeding water bodies in the forest landscape should be added to the current list of breeding areas being surveyed annually by Alberta Sustainable Resource Development. These surveys also provide an indication of fledging success and should be used to assess the efficiency of management activities.

<u>Water Bodies (amphibians)</u>: The three focal amphibian species require suitable water bodies for at least one part of their life cycle. Although western toad and northern leopard frog prefer breeding in shallow water (<1 m), the long-toad salamander, especially at high elevation (> 1700 m), requires deeper water bodies that do not completely freeze so that larvae can overwinter (Pearson 2004a). Similarly, the northern leopard frog requires deeper ponds that do not freeze in

the entire water column so that it can overwinter in the mud (Pearson 2004b). In addition, the long-toad salamander and the northern leopard frogs at the larval stage of their life cycle are vulnerable to predatory fish. It is therefore imperative that potential water bodies for the three focal amphibian species be surveyed for these species and that active sites be identified and mapped. The practice of stocking fish in fishless water bodies should be discontinued in the entire southern headwaters area. Also, see next section and discussion on riparian areas for lakes with little or no recreational, waterfowl, or sport fishing potential.

6.2.2 Riparian Areas Management

Riparian areas perform critical ecological functions (see review in Fitch *et al.* 2001). In the SHARP forest landscape, they provide predator cover, and nesting or breeding and feeding opportunities for the harlequin duck, the pileated woodpecker, and the vagrant shrew, and serve as habitat and/or as dispersal corridors for the three amphibian focal species (long-toed salamander, western toad, northern leopard frogs) and the vagrant shrew between important seasonal habitats (ASRD 2003a, Pearson 2005, see Volume 4). Maintaining a healthy forested riparian area of suitable width is thus essential to ensure that the processes upon which these species are dependant are present. Current Alberta timber harvest planning and operating ground rules (Anonymous 1994) call for undisturbed buffer strips of 30 m and 60 m on either side the high-water mark of any small permanent and large permanent watercourses respectively. Intermittent watercourses receive an unspecified buffer width of undisturbed brush and lesser vegetation, while ephemeral watercourses receive an unspecified buffer width of undisturbed "lesser vegetation" (Anonymous 1994). These forest management treatments, where applied, are likely suitable to permit recruitment of large woody debris within and along streams (McMahon and Hartman 1989) and to provide habitat and/or dispersal corridors for the harlequin duck, pileated woodpecker (see Forest Structure and Composition section below) vagrant shrew, long-toed salamander, western toad, and the northern leopard frog (K. Pearson, pers. comm.; Vesely and McComb 2002, also see Robertson and Goodie 1999, Dickerson 2001, and Richardson *et al.* 2002) and should be implemented. In addition, random camping on public land should occur outside these buffer zones. The Government of Alberta has established a set of guidelines that allows random camping at a minimum distance of 30 m away from any watercourse (ASRD 2003B). Although this distance would likely be suitable for the focal species, these guidelines are often ignored and heavy disturbance of the riparian zone can be observed in the southern headwaters area (F. Blouin, pers. obs.). This minimum distance guideline should therefore be converted into a regulation and enforced. Access in this zone should also be restricted to pedestrians. Official trails and roads should be restricted to perpendicular crossings and should be limited.

Alberta timber harvest planning and operating ground rules (Anonymous 1994) also require that a 100 m buffer zone be left undisturbed around lakes with recreational, waterfowl, or sport fishing potential exceeding 4 ha in area (unless specifically approved in the Annual Operating Plan). However, these lakes often include native or introduced predatory fish that may limit amphibian populations or sometime cause local extinctions (Pearson 2004a, b, c). For lakes with little or no recreational, waterfowl, or sport fishing potential, the ground rules allow an undisturbed 100 m buffer zone only around those that exceed 16 ha in area. Treatments around smaller lakes that do not contain fish and that might present a high potential for amphibians are

left at the discretion of the timber harvest operator (J. Bruha, pers. comm.). Newer ground rules are being developed for the C5 Forest Management Unit that will see the minimum lake area with a 100 m buffer requirement reduced to 4 ha for that category (J. Bruha, pers. comm.). However, these rules will not be available for a year or two. Unfortunately, water bodies less than 4 ha in area are often highly suitable to amphibians. For example, in the SHARP region, long-toed salamanders have been observed to breed in water bodies ranging from approximately 0.006 to 10 ha in size (Pearson 2004a). Modifying the riparian area of small lakes is likely to have an important impact on water quality (chemical and physical properties) and thus on their suitability for breeding or developing amphibians. In addition, long-toed salamanders and northern leopard frogs at their terrestrial stage, as well as the vagrant shrew, are known to utilize habitat near water. Long-toed salamanders spend the majority of their active period within 500 m of their breeding pond (Pearson 2004a), while northern leopard frog may use an area within 200 m of the water's edge for feeding (Smith 2003). It is therefore imperative that potential water bodies for the three focal amphibian species be surveyed for these species and that active sites be mapped and provided to timber harvest operators. Alberta timber harvest planning and operating ground rules should be modified to include identified key water bodies for amphibians. These should also receive an undisturbed 100 m buffer around them. Around other small unoccupied water bodies, areas with patches of shrubs and deciduous trees such as *Alnus* spp., *Betula* spp., *Salix* spp., and possibly *Cornus stolonifera* and *Acer glabrum* in dry or moist wooded or open habitats and in riparian situations should be maintained to ensure the continued presence of vagrant shrews.

In naturally non-forested habitats, healthy riparian corridors that also provide feeding opportunities for amphibians (Bugg and Trenham 2003, ASRD 2003a) and vagrant shrews (see Clothier 1955 and Wallis *et al.* 2002) should be maintained. In grazed areas, degraded riparian zones should be restored to health through fencing, control of stocking rates, distribution of livestock pressure, and/or temporal grazing and rest management (see Fitch *et al.* 2003).

More research on the benefits and the width of riparian buffer strips on these species' populations is needed and should also be pursued in the southern headwaters area.

6.2.3 Other Terrestrial Linkages

Terrestrial linkages are also essential for the movement and dispersal of the amphibian focal species. Wherever watercourses are absent, non-harvested corridors of at least 100-200 m (Pearson 2005) should be retained between key occupied water bodies in areas targeted for timber harvesting. However, further research is needed to determine the efficiency and the appropriate widths of these corridors and their permeability to amphibians, and harvest strategies (e.g., no harvest, selective harvest). These corridors should be placed in most direct and most likely (e.g., thick litter ground cover) locations.

Movement corridors (terrestrial or riparian) should be permeable in their entire length and should include woody debris. Linear features (e.g. roads and trails) and other human infrastructures should be located away from these corridors. Where this is not possible or where human features have already been established, underpasses (tunnels) and fencing should be built to allow for safe crossing of amphibians and vagrant shrews (Ovaska *et al.* 2004). Ovaska *et al.* (2004) provide

details for the construction and location of drift fences and tunnels for amphibian crossings, which would also likely be suitable for the vagrant shrew. Downed woody debris in various stages of decomposition and rocks should be left within all corridors for cover and prey habitat.

6.2.4 Forest Structure and Composition

The pileated woodpecker is highly dependant on large snags or live trees with sound sapwood at the cavity entrance and fungal-softened heartwood for nesting and roosting, and snags and living trees that harbor carpenter ants, as well as logs and stumps for feeding (Bonar 2001, 2003a). Although often associated with mature or old forests, the presence and density of large trees for nesting and roosting appears more important than the actual forest age (Bonar 2001).

In areas targeted for harvesting of priority LMUs, all current and some potential cavity trees should be identified prior to or during harvesting operations and retained. Further details on how to identify cavity trees are provided in Volume 4. To maximize the chance of pileated woodpeckers and other species reusing the cavity trees, the approach should vary from protecting individual cavity trees to protecting a portion of the stand they are found in (Bonar 2001). Bonar (2001) defines potential cavity trees as "living or dead deciduous species and dead coniferous species ≥30 cm diameter at breast height (dbh)". Trembling aspen (*Populus tremuloides*) or balsam poplar (*Populus balsamifera*) are preferred but coniferous species are acceptable where deciduous trees are not abundant (Bonar 2001). In the southern headwaters many of the larger trees are coniferous (especially Douglas fir), and these should be treated in the same manner Bonar describes for deciduous trees in the Foothills Forest. Stands that have or can be expected to develop large trees should be protected. As each pair of pileated woodpeckers defends mutually exclusive territories on average about 2000 ha in size in west-central Alberta (Bonar 2001), at least 2% of stands (≥5 ha in size) with potential cavity trees should be protected per 2000 ha area (Bonar 2001). These stands could occur in the movement corridors mentioned above. In harvested areas, some living trees with or without decay should be protected to provide for future cavity trees (Bonar 2001). These should be distributed throughout the area as single trees, clumps, or patches. If the pre-harvest area doesn't contain large trees, it may not be necessary to retain potential cavity trees. Cut blocks should contain a density of potential cavity trees of 0.1-0.3 per ha.

Stumps, snags and living trees with visible rectangular holes should also be retained as foraging substrates for the pileated woodpeckers (Bonar 2001, Bonar 2003a). Details on how to identify these foraging substrates are also provided in Volume 4. Living trees or relatively sound dead trees have higher foraging value to the pileated woodpecker and should be retained as potential foraging substrate. Wobbly trees or soft trees have higher safety concerns and lower foraging value for pileated woodpeckers. Trees with base damage such as fire scars and stem cracks, or other defects such as conks and crooks could be selected for retention, and could be "high stubbed" at or above three metres if necessary to address safety concerns or to recover merchantable wood volume (Bonar 2001, 2003a). Retained trees as foraging substrates should also vary from widely distributed individual trees or stumps to clumps or patches of trees of various sizes. Younger trees at different developmental stages including understory trees should also be protected, allowing for future cavity or foraging substrates to be available for several decades before regenerated trees become suitable to the pileated woodpecker (Bonar 2003a, b).

In each 2000 ha area, at least 5% of stands with potential foraging substrates should be protected (Bonar 2001). Potential cavity tree stands can also qualify as potential foraging substrate stands. In addition to existing foraging substrates, harvested areas should contain a density of potential winter foraging substrate of 5-12 trees per ha.

6.2.5 Threatening Processes

Several factors have been suggested as potentially causing the world-wide decline of amphibians, including pesticides. Recent studies have shown that direct overspray of the widely used Roundup® (glyphosate + surfactant polyehtoxylated tallowamine) at manufacturer's recommended rates is highly lethal to several species of aquatic and terrestrial amphibians, including the northern leopard frog (Relyea 2005a,b). Herbicides (including glyphosate) are used on Alberta's public land as a silvicultural tool to establish, maintain and/or improve the growth of desirable tree species (ASRD 2004). Although pesticide application over and within 30 horizontal metres of an open body of water is regulated in Alberta by the *Pesticide Sales, Handling, Use and Application Regulation*, the definition of an "open body of water" excludes ponds or dugouts that have no outlet, are completely surrounded by private land, and are less than 4 ha in area, roadside ditches and small (< 0.5 m wide), dry intermittent streams, and reservoirs, lakes, marshes or other bodies of water that are located on public land, that have an area of less than 0.4 hectares, and have no outflow of water (Anonymous 2005). These smaller bodies of water are often highly suitable for breeding and developing amphibians (including the three focal species of amphibians) because they lack predatory fish and may contain warmer water that accelerate development (see Pearson 2004a,b,c). In addition, they are vulnerable to direct overspray or drift from aerial application. Roundup® may have a significant impact on amphibian populations in the southern headwaters area and should be prevented from entering <u>any</u> body of water suitable for breeding and developing amphibians. Therefore the definition of "body of water", at least for the areas being managed for the focal species, should include any body of water 30 cm or more deep (see Pearson 2004b). Aerial application of Roundup® should be prohibited, while ground application should follow the guidelines for the use of herbicides for silviculture in Alberta (ASRD 2004) and comply with the Alberta *Code of Practice for Pesticides*, but completely exclude riparian areas and terrestrial movement corridors (see above), unless the purpose of the application is to control herbaceous plants classified as "restricted" or "noxious" weeds under the *Weed Control Act*.

6.3 Grassland Landscape

Landscape management units (LMUs) in the grassland landscape of the southern headwaters area were based on the political quarter section unit as determined by the Alberta Township System. Quarter sections were assessed one of five priority categories based on their relative multi-conservation value index (MCV) per hectare (Appendix 3). Management activities should therefore be applied to the highest categories LMUs, with threshold category being determined by the land manager based on the amount of resources available.

6.3.1 Grassland Structure and Composition

Prairie birds and mammals have evolved and adapted to the pattern of vegetation resulting from such processes as grazing, drought, fire, and flooding. Grassland focal species are thus directly or indirectly dependant on specific grassland structure and/or composition for breeding and hiding cover, and foraging habitat. The sharp-tailed grouse depends on low and sparse vegetation during courtship display and mating and on a mosaic of dense grass and shrubs during the nesting and brood-rearing period. The Sprague's pipit is found more often in native grass of intermediate height and density with a litter of moderate thickness, where little or no woody vegetation occurs. The long-billed curlew on the other hand prefers nesting in a matrix of shorter vegetation where patches of taller grass provide nesting cover. Brood-rearing habitat generally has higher vegetation and greater vertical density than nesting sites.

Other species, such as the loggerhead shrike, the ferruginous hawk, and the prairie falcon are also indirectly dependant on specific grassland structure through the habitat needs of their prey. Ground squirrels that make up the bulk of the ferruginous hawk's and the prairie falcon's diet occur predominantly in short grass. Prey species for the loggerhead shrike, such as grasshoppers, mice and voles, favour taller grass, but a matrix of shorter grass increases hunting efficiency for the shrike. These foraging habitat requirements must also include suitable nesting habitat.

Managing for multiple grassland species therefore involves addressing the complexity of habitat requirements at multiple scales. At the grassland landscape level, management activities should favour a spatial distribution of LMUs with generally taller grass in the Foothills Fescue natural subregion to the west, and shorter grass in the Mixedgrass subregion to the east, to reflect the natural pattern shaped by the species composition in each natural subregion. At the landscape management unit (LMU) scale affecting the prairie falcon and the ferruginous hawk, management activities should provide for an unfragmented matrix of shorter vegetation favouring ground squirrels, with patches of intermediate to tall grass, low and taller shrubs, and scattered trees. The presence of limiting resources (e.g., ground squirrel concentrations, leks, nesting trees or shrubs; see below), should dictate the type, location, and the scale of management of some patches. For example, within about 2 km (nesting complex) of a lek, management activities should favour a mosaic of low shrubs, and dense grass and forbs with extensive structure (see also "Beneficial Management Practices" for the sharp-tailed grouse in Volume 4). Vegetation around ground squirrel concentrations should be kept short and grassy. In relatively flat areas where scattered dense thorny shrubs, willows, or low trees are present, grass of different heights should offer some structure within a matrix of mostly short vegetation for the loggerhead shrike, within 400 m of these nesting substrates (see also "Beneficial Management Practices" for the loggerhead shrike in Volume 4).

In LMUs where limiting resources are absent, areas of similar grass height or similar pattern should be arranged so that they are adjacent between adjacent LMUs. This would result in large unbroken areas of similar habitat and favour larger populations of interior species. For example, the Sprague's pipit nests in areas of intermediate grass height and appears to be area sensitive (Dechant *et al.* 2003a). Large patches of suitable habitat may also decrease the rate of nest depredation and brown-headed cowbird parasitism (Dechant *et al.* 2003a).

Several management practices exist (*e.g.*, grazing systems, prescribed fire, mowing, etc.) to accomplish the desired pattern and composition of vegetation. Grazing is probably the most versatile, and widespread, and accepted land use for grasslands in the southern headwaters area. Timing, intensity, frequency, and distribution of defoliation can be adjusted to achieve the desired vegetation objectives according to the season, climatic conditions, and local environmental conditions (ecological site; see Adams *et al.* 2003, 2004). Rangeland Conservation Service Ltd (2004) provides a summary of the grazing systems that can be used to achieve various management objectives in native prairie. At the local scale, livestock movement and grazing intensity can be manipulated by placing salt, mineral, supplemental feed, or off-site watering systems at strategic locations (Fitch *et al.* 2003, Rangeland Conservation Service Ltd 2004) and at strategic times of the year.

Rough fescue is believed to have evolved under a fire frequency of 5-10 years (Jourdonnais and Bedunah 1990, Adams *et al.* 1992). Periodic burning could also be used in combination with grazing to reduce encroachment by woody species and removes litter accumulation (Jourdonnais and Bedunah 1990, Gerling *et al.* 1995; also see "Woody Vegetation Encroachment" below). According to Adams *et al.* (1992), the major obstacle to the use of fire to manipulate native prairie vegetation in the southern headwaters area is the safety concern associated with burning in this high risk, chinook-prone environment.

6.3.2 Limiting Resources Management

<u>Nesting Sites</u>: Several focal bird species in the grassland landscape of the southern headwaters area are dependant on specific structures or components of their habitat for nesting, and those need to be identified, protected, and monitored. The prairie falcon needs secure cliff sites in native prairie in proximity of an abundant source of ground squirrels (see discussion on ground squirrels below). In the southern headwaters area, these are often located along large rivers or within the rugged Porcupine Hills. Similarly, the ferruginous hawk nests in lone trees or shrubs, cliffs, rock outcrops, or sometimes on the ground, and in artificial structures such as utility towers. The loggerhead shrike requires thick scattered thorny shrubs or low trees for nesting. Trees and shrubs used by the ferruginous hawk or the loggerhead shrike could be fenced-off where they are vulnerable to rubbing by cattle. Sharp-tailed grouse are dependant on elevated areas characterized by low and sparse vegetation for their courtship displays (Johnsgard 1973; Connelly *et al.* 1998). Those "leks" form the centre of their breeding complex and are used year after year (see also discussion on breeding complex in the "Grassland Structure and Composition" section).

<u>Water Bodies (trumpeter swan)</u>: Most suitable water bodies for the trumpeter swan occur in the grassland landscape (R. Quinlan, unpublished HSI model). Highly suitable water bodies in the priority areas should be added to the list of those being surveyed annually during the breeding season by Alberta Sustainable Resource Development, if not currently surveyed. Spring and fall migration surveys should also be conducted to identify important staging water bodies. Where trumpeter swans occur, an access management plan should be developed and implemented according to their seasonal use by the swans in order to minimize the impact of human disturbance on and in proximity of water bodies. The BMPs presented in Volume 4 and the land use guidelines developed and modified by the Alberta Fish and Wildlife Division (2001) should

be implemented in the area. As in the forest landscape, fledging success should be used to assess the efficiency of management activities.

Water Bodies (amphibians): Clean and secure breeding water bodies with shallow areas (<1 m) and well oxygenated overwintering ponds that do not freeze in their entire water column are essential habitats to northern leopard frogs (Pearson 2004b). Breeding water bodies for the long-toed salamander are generally permanent in nature (Pearson 2004a). At the larval stage of their life cycle, the northern leopard frog and the long-toed salamander are particularly vulnerable to predatory fish. Potential water bodies for these species should be surveyed and active sites identified and mapped. As mentioned in the forest landscape, the practice of stocking fish in fishless water bodies should be discontinued in the entire southern headwaters area. Breeding sites should be fenced off to prevent cattle from entering water bodies. The use of off-site or off-stream watering systems should be developed where deemed necessary. Sudden water fluctuations in breeding water bodies resulting from water management practices should also be prevented. Water fluctuations should try to mimic natural water fluctuations for the area in periods of normal to high water levels, but ensure water availability for completion of larval metamorphosis during dry periods. Where changes cannot be made to water management practices, a water body adjacent to the one where water management occurs may need to be created and managed for the northern leopard frog and long-toed salamander. Also see next section and discussion on riparian areas.

Ground Squirrels: Ground squirrels are the primary food source to both focal species: the ferruginous hawk and the prairie falcon. However, in the agricultural community, they are perceived as pests and often controlled directly through shooting or indirectly through the use of rodenticides. When control of ground squirrel populations is necessary, it should be directed at reducing peaks of cyclic highs rather than completely exterminating them (Dechant *et al.* 2003b). The erection of artificial raptor nesting platforms at key locations in the vicinity of ground squirrel concentrations could be used as a natural mean of controlling local populations in the SHARP grassland landscape, while potentially benefiting nesting ferruginous hawks. Landholder education directly through presentations or coffee shop discussions or indirectly through fact sheets or other communication materials is an important tool at preventing the pointless destruction of these key animals.

Limiting resources, either actively used or of high potential for the focal species, need to be identified and mapped. Those resources should be protected and should remain undisturbed (see "Land Use Guidelines" in Volume 4 for details on timing of human activities, minimum distance to respect, and activity types for individual species). An updated map presenting the locations of these limited resources needs to be provided on a regular basis to all land managers, including those of First Nations reservations, and municipal governments, and to resource extraction and utility companies for their development planning. Monitoring of those sites at an appropriate time of the year may provides an indication of population trends and habitat quality and should be conducted on a regular basis and over the course of several years (also see "Monitoring" section below).

6.3.3 Riparian Areas Management

Healthy riparian areas in the grassland landscape are essential at providing important feeding habitat and hiding cover to the sharp-tailed grouse, the long-toed salamander and the northern leopard frog, in addition to providing breeding habitat to the loggerhead shrike and movement corridors to the northern leopard frog between essential habitats. Areas with surficial deposits of a fluvial, aeolian, glaciofluvial, or lacustrine nature are particularly important to long-toed salamanders (Graham and Powell 1999). Grazing in the riparian area should be well monitored to prevent degradation of this sensitive zone. The Cows and Fish program has developed four key grazing management principles to promote healthy riparian areas that should be implemented in priority LMUs (Fitch *et al.* 2003). These are: 1) balancing animal demand with available forage supply through an understanding of carrying capacity and adequate stocking rates, 2) distributing the livestock pressure evenly and avoiding overuse of the area through several potential management tools to spread the grazing over the landscape, 3) avoiding or minimizing grazing in the riparian area during vulnerable times (e.g. when the area is saturated with moisture and vulnerable to trampling or in the fall when woody vegetation is still green and vulnerable to overuse), and 4) providing an effective rest period after grazing and during the growing season.

Watershed-based community efforts, such as the Beaver Creek Watershed Group (BCWG), working as stewards of a watershed in improving water quality and ensuring healthy riparian areas should be encouraged and developed throughout the SHARP landscape. The Cows and Fish Program provides excellent support for this type of organization and for private landowners, through education, technical assistance and tools to maintain or restore the ecological processes and functions of riparian areas.

6.3.4 Other Terrestrial Linkages

Movement corridors for the northern leopard frog are not well understood in the southern headwaters area. Dispersal of young of the year from their natal pond and adult migration between their overwintering site, their reproduction pond, and their summer feeding area is believed to occur mostly along aquatic corridors, but may also take place over land on rainy nights or in morning dew (K. Kendall, pers. comm.). Telemetry work over several years may be required to establish the nature of these movement corridors, their location, and their relative importance to the different age classes of northern leopard frogs in the southern headwaters area. However, it is likely that vegetation (grass or shrubs) cover is important in movement corridors (see also discussion above on riparian areas).

Movement corridors (terrestrial or riparian) for amphibians should be permeable in their entire length. Linear features (e.g. roads and trails) and other human infrastructures should be located away from these corridors. Where this is not possible or where human features have already been established, underpasses (tunnels) and fencing should be built to allow for safe crossing of amphibians (Ovaska *et al.* 2004). Ovaska *et al.* (2004) provide details for the construction and location of drift fences and tunnels for amphibian crossings.

6.3.5 Threatening Processes

Woody Vegetation Encroachment: Encroachment of woody vegetation on native grassland resulting from fire suppression policies provides nesting habitat for red-tailed and Swainson's hawks who compete with ferruginous hawks (Schmutz 1999), and decreases the habitat suitability for other focal grassland species such as the Sprague's pipit, long-billed curlew, loggerhead shrike, and sharp-tailed grouse (Landry 2004, Downey 2004b, Jones 2004). A combination of control burns and grazing could be used as a management tool to reclaim areas of grassland that have been encroached by woody vegetation. Fire and grazing can set succession back and prevent woody vegetation from encroaching into the grasslands (Wright and Baileys 1982, Bradley and Wallis 1996). In the aspen parkland of Alberta, short-term heavy (25-27 animals/ha) browsing by cattle in late August following a spring (May) burn of a seven year-old aspen forest was effective at controlling aspen suckers (Fitzgerald and Bailey 1984). Care should be taken to avoid burning during the nesting season. Burning in the fescue prairie should be conducted during spring while rough fescue is still dormant. This will increase tillering and may compensate for decreased tiller length (Gerling *et al.* 1995). A burn frequency of once every 5-10 years should be applied to mimic pre-European conditions under which rough fescue evolved (Jourdonnais and Bedunah 1990, Adams *et al.* 1992), but this may be reduced if grazing is applied following fire. Mechanical treatments, and the placement of cattle mineral, oiling, or watering stations at strategic locations within shrub patches can also be used alone or in combination with controlled burns if deemed necessary to reduce large solid stands of woody vegetation (Giesen and Connelly 1993, Miller 1999, Roersma 2001). However, individual trees, a mosaic of stands of trees, or a thin scattering of trees could be left behind to provide nesting substrates for the ferruginous hawk, while scattered low, thick shrubs and trees could be left behind for loggerhead shrikes (Olendorff 1993; cited in Dechant *et al.* 2003b, Dechant *et al.* 2003c).

Pesticide Use: Pesticides can have a direct negative impact on northern leopard frog and possibly long-toed salamander populations. In addition, insecticides can have an indirect effect on birds and amphibians by decreasing prey populations. However, the surfactant used in some glyphosate-based herbicide formulations, polyethoxylated tallowamine (POEA), is of particular concern to this species at environmentally relevant concentrations (see Relyea 2005a,b, and Howe *et al.* 2004). Although pesticide application over and within 30 horizontal metres of an open body of water is regulated in Alberta by the *Pesticide Sales, Handling, Use and Application Regulation*, the definition of an "open body of water" excludes ponds or dugouts that have no outlet, are completely surrounded by private land, and are less than 4 ha in area, roadside ditches and small (< 0.5 m wide), dry intermittent streams, and reservoirs, lakes, marshes or other bodies of water that are located on public land, that have an area of less than 0.4 hectares, and have no outflow of water (Anonymous 2005). These smaller bodies of water are often highly suitable for breeding and developing northern leopard frogs because they lack predatory fish and may contain warmer water that accelerate development (see Pearson 2004b). In addition, northern leopard frogs, and possibly long-toed salamander, are vulnerable to unintentional overspray, aerial drift, or runoff. Herbicide formulations containing POEA (e.g., Roundup Original®, Roundup Transorb®, e.g., Glyfos AU®; Howe *et al.* 2004) may have a significant impact on amphibian populations in the southern headwaters area and should be prevented from entering any body of water suitable for breeding and developing amphibians. Therefore the definition of

"body of water", at least for the areas being managed for the focal species, should include any body of water 30 cm or more deep (see Pearson 2004b). Aerial application of POEA-containing herbicides should be prohibited, while ground application should follow the guidelines for the use of herbicides for silviculture in Alberta (ASRD 2004) and comply with the Alberta *Code of Practice for Pesticides*, but completely exclude riparian areas and identified terrestrial movement corridors (see section "Other Terrestrial Linkages"), unless the purpose of the application is to control herbaceous plants classified as "restricted" or "noxious" weeds under the *Weed Control Act*. A communication strategy needs to be developed to educate landholders in the vicinity of known or high potential habitats for the northern leopard frog about the toxic effect of certain herbicides to native amphibians and the impact of insecticide use on prey populations. Alternative herbicides (e.g., Roundup Biactive®, Touchdown®, or Glyfos BIO®) that appear less toxic to amphibians (Howe *et al.* 2004) should be recommended to them.

<u>Fertilizers</u>: Unintentional application of nitrogen-based fertilizers into water bodies or runoffs from adjacent land can have direct and indirect impacts on developing northern leopard frogs. A communication strategy needs to be developed to educate landholders in the vicinity of known or high potential habitats for the northern leopard frog about the potential impacts of fertilizers on amphibians and ways to minimize these impacts.

7.0 MONITORING

An effective monitoring program is an essential part of any management strategy to ensure that the implemented activities are achieving the objectives set forward in the project. In both landscapes, baseline data should be gathered immediately after implementation of management activities and monitoring should take place periodically thereafter and over several years. This will ensure that long-term effects are detected and that management prescriptions are re-assessed and adjusted according to the conservation objectives and within the context of adaptive management theory. The amount of data required and the length of monitoring will depend on the objectives of the monitoring program. Information gathered may include presence/not detected data to address whether a species is actually using the habitat being managed or the structures that were constructed. It could also involve collecting population parameters (e.g., demographics, reproductive output, immigration, dispersal, etc.) to detect whether the area being managed is actually acting as a source or a sink for the species.

8.0 CONCLUSION

In a context of limited resources to manage an increasing number of species, wildlife managers must sometimes rely on creativity to ensure the conservation of species at risk and prevent others from becoming at risk. The Southern Headwaters at Risk Project provides a holistic approach to managing multiple species at risk in the headwaters area of the Oldman River and ensure the long-term sustainability of their populations. In a first step, a group of focal species that are most representative of species with similar habitat requirements and threats were selected (Blouin *et al.* 2004). Threatening processes were subsequently determined for each of these focal species (see Volume 4). High potential areas for the occurrence of multiple focal species were identified and mapped at a unit that is relevant to the most area-limited species. In the present volume, we presented a list of management recommendations to apply at the landscape level and at the

management unit level. These were developed to limit or reverse the impact of threatening processes and address the complexity of habitat requirements of multiple species at multiple scales.

In the forest landscape, the need for space by the wolverine requires a management strategy to apply at the full scale. At the landscape management unit scale, the management of limited resources, such as limber and whitebark pines and water bodies, is essential to ensure the conservation of Clark's nutcracker, trumpeter swans and amphibian populations. Ensuring healthy riparian areas, terrestrial linkages, specific forest structure and composition and limiting such processes as the application of particular herbicides, is fundamental to maintain populations of forest focal species.

In the grassland landscape, grassland composition imposes managing for a gradient in vegetation structure from shorter grass in the Mixedgrass natural subregion to taller grass in the Foothills Fescue natural subregion. At the landscape management unit level, the presence of limiting resources (e.g., water bodies, ground squirrel colonies, and nesting substrates) dictates the type, location, and the scale of management of habitat patches. In other areas, a mosaic of large patches of variable vegetation structures, the maintenance of healthy riparian areas, the presence of suitable terrestrial linkages, and the control of threatening processes such as vegetation encroachment, the use of certain pesticides, and the improper use of fertilizers, should ensure that the habitat requirements of all grassland focal species are met.

Management activities must also be accompanied by an adequate monitoring strategy. By assessing the effectiveness of the management activities, wildlife managers can establish if changes to their approach must be brought about in order to achieve their management objectives.

Managing for the conservation of multiple species in a landscape dominated by multiple land uses, multiple ownerships, and multiple governments, requires major cooperation between stakeholders. Stakeholders must be informed of the motives that prompted the development of the Southern Headwaters At Risk Project and of its objectives. An important next step in this project entails developing a suitable communication strategy that provides the public with complete and accurate information and allow for input. The strategy must also ensure that the various governments, public land managers, developers, and landowners are provided with the tools and guidance (e.g., maps of sensitive areas, land use guidelines, management recommendations for the focal species) to assist them in selecting activities and land uses that are compatible with focal species conservation. In addition, private landowners' cooperation in this conservation project will likely be greatest and most effective if the conservation measures that are presented to them are in the form of voluntary stewardship actions rather than imposed on them. Moreover, the Southern Headwaters at Risk Project will only be successful at meeting its objectives if financial, human, and material resources are committed to sustain its implementation, development, and monitoring over the course of several years.

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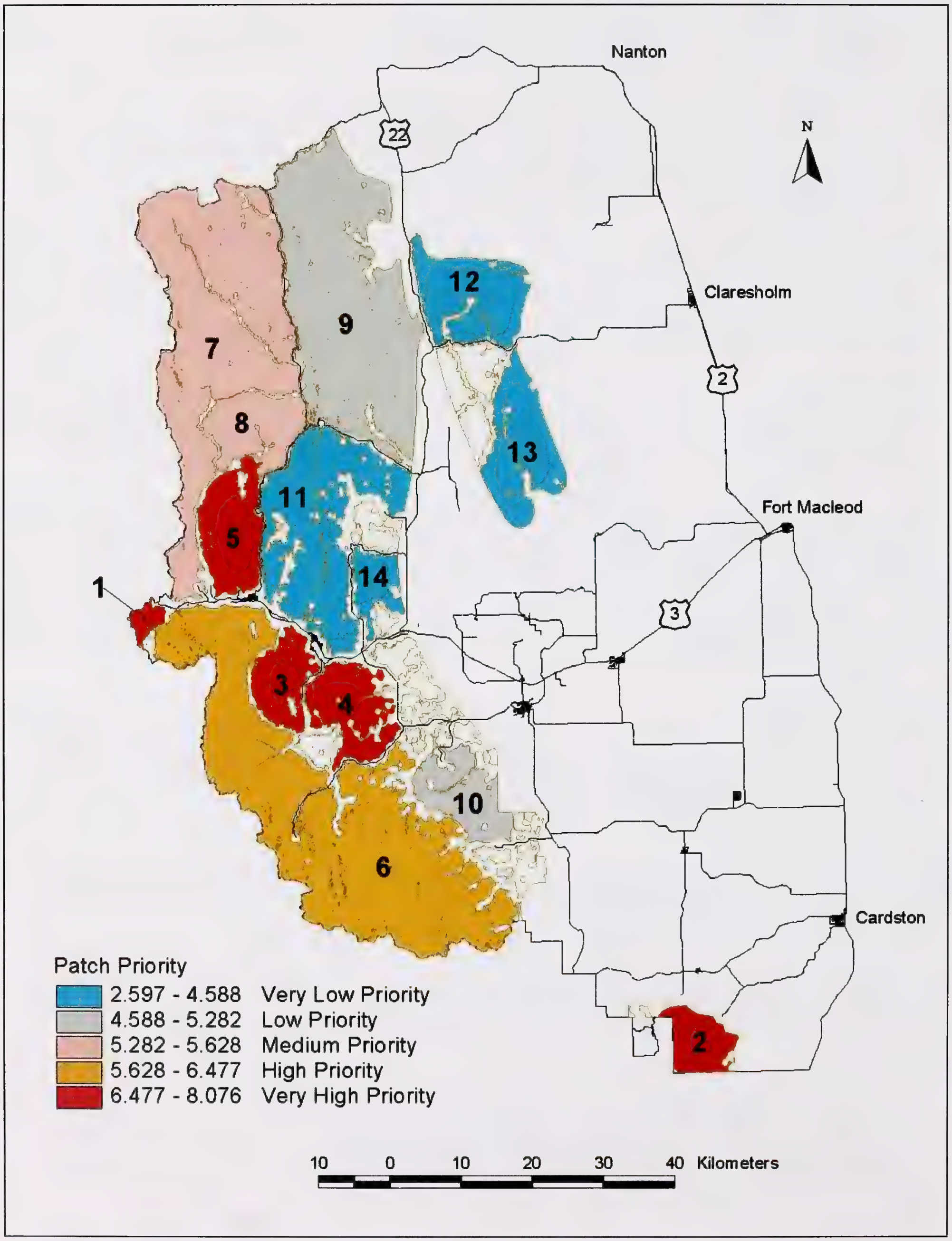
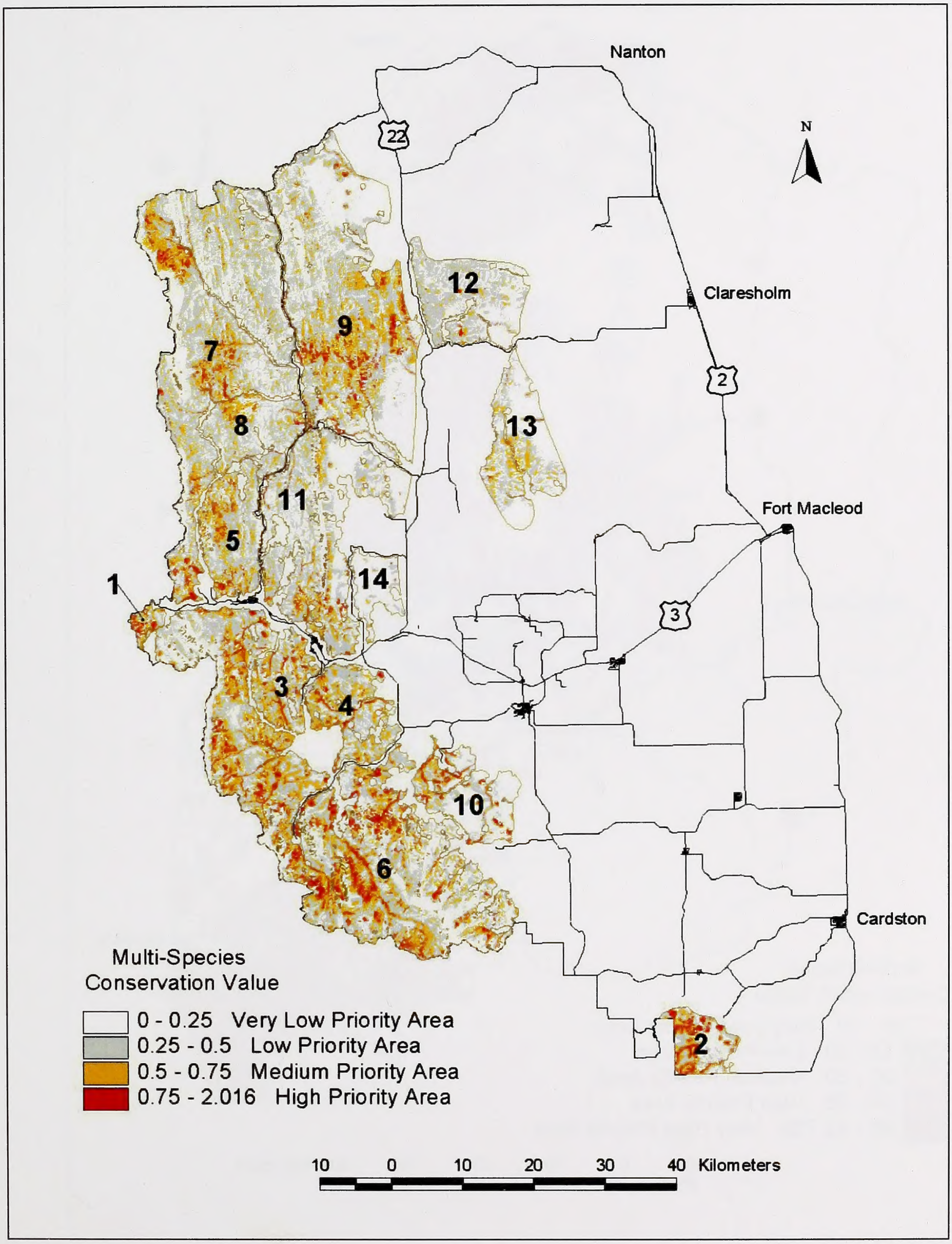
Appendix 1. Prioritized forest landscape for the conservation of multi-species at risk in the SHARP area. Blank patches (LMUs) did not meet the minimum area requirement (see text). Numbers represent order of landscape management unit priority.



Appendix 2. Priority areas for habitat stewardship activities in LMUs of the SHARP forest landscape.



Appendix 3. Priority quarter sections (LMUs) for habitat stewardship activities in the SHARP grassland landscape.